FINAL REPORT

PROJECT NO. A-566

TENSILE STRENGTHS OF STEEL CONNECTIONS HAVING TRANSVERSE AND LONGITUDINAL FILLET WELDS

By Olin S. Lord and F. W. Schutz, Jr.

Prepared for
Bureau of Yards and Docks
Department of the U. S. Navy

Contract NBy 37614   22 January 1963

Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia

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July 1, 1961 through June 30, 1962

ACKNOWLEDGEMENTS

The authors wish to express appreciation to all those whose assistance and generosity contributed to the successful completion of this project. Mr. A. A. Amirikian, U. S. representative to Committee XV, International Institute of Welding, was largely responsible for these tests being conducted.

Bethlehem Steel Company generously donated most of the steel plates required for the test specimens. The fabrication of the test specimens was handled by J. J. Finnigan Company, of Atlanta, Georgia.

ABSTRACT

The test data from a series of tests on steel connections having transverse and longitudinal fillet welds is reported in this paper. The master data sheets are to be sent to Professor van Douwen, Oostplantsoen 25, Delft, Holland, where all computations needed for drawing conclusions, etc., will be handled. Testing techniques, procedures and test data are all that will be included in this report.

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INTRODUCTION

This research project was conducted at the Georgia Institute of Technology under the direction of Dr. F. W. Schutz, Jr., Director of the School of Civil Engineering. The project, as proposed by the Netherlands Delegation to Commission XV of the International Institute of Welding, consists of a series of tests on fillet welds to be carried out in several countries. (1)* Mr. A. A. Amirikian is the United States representative to Committee XV and was largely responsible for these tests being carried out. The collective results should prove or disprove the applicability of their proposed design method for such joints where varied fabrication and loading conditions are imposed on a variety of structural steels. This project was sponsored in the United States by the Bureau of Yards and Docks, Department of the Navy, under Contract No. NBy 37614.

Test specimens of prescribed dimensions were built and tested under tensile loads. The weld pattern was symmetrical with fillet welds either transverse, longitudinal, or both, with the direction of the applied force. Variables of major concern were the ratio of transverse and longitudinal weld lengths and throat depths, stress level in the steel and the influence of varying the type of electrode.

Main test specimens conforming to particular combinations of the variables were augmented by four auxiliary specimens. These auxiliary specimens had the same variables as the main specimen except one variable was changed. This gave an indication of the effect of that particular variable on the main test specimen.

* Numbers in parenthesis indicate references

DESCRIPTION OF TESTS

Test Specimens

In order to eliminate as many undesirable variables or by-products of fabrication as possible, particular care was taken in planning the fabrication of the test specimens. Steel plate classified as American Society for Testing Materials Designation A-36 (2), was selected because of its superior welding characteristics. Plate stock was used so that the components of the test specimens could be cut from the interior of the plates and reduce the effect of residual stresses induced in the steel during the manufacturing process. To insure as much uniformity in the steel as possible, all plates of equal thickness were taken from the same heat. This means the plates of equal thickness had the same chemical and physical properties.

The components of the test specimens were numbered for control purposes and then scribed onto the surface of the steel plates as shown in Figures 1 through 5. The components were flame cut by an automatic torch. Heat effects from the cutting were small and they were virtually eliminated by milling off the heat affected zone on those edges which were to be welded. Also, during assembly of the specimens, care was taken to insure that the welded ends of the components were from the interior of the parent plates and not from a free edge.

Electrodes

Acid coated. Basic and rutile electrodes were specified as the three types of electrodes to be used by IIW Doc. XV-121-61. (1) After considerable search the following three electrodes were selected:

Rutile: E 7014 (AWS), Iron Powder (approx. 30%) AC or DC $\pm$

As Welded:	Tensile strength	5060 to 5630 Kg/cm^2
	Yield point	4220 to 4920 Kg/cm^2
	Elongation	17-29 %
	Impact	55 ft. lbs.

Basic: E 7018 (AWS), Low Hydrogen, Iron Powder (approx. 25%) AC or DC ±

As Welded:	Tensile strength	4920 to 5630 Kg/cm^2
	Yield point	4220 to 4920 Kg/cm^2
	Elongation	22-30 %
	Impact	119 ft. lbs.

Acid: E 6027 (AWS), Mineral, Iron Powder (approx. 50%) AC or DC ±

As Welded:	Tensile strength	4360 to 5060 Kg/cm^2
	Yield point	3520 to 4500 Kg/cm^2
	Elongation	25-30 %
	Impact	60 ft. lbs.

Determination of Physical Properties

As indicated on the layout patterns (Fig. 1 through Fig. 5), a strip was provided for tensile coupons adjacent to one edge of every component of the test specimens. These strips, numbered 1 through 63, were milled into standard eight inch (20.3 cm) gage length tensile coupons and tested accordingly to ASTM specifications. (3) The data from these coupons is reported in Table 1. Information shown on the master data sheets (See Appendix C) pertaining to properties of the parent material, was taken as an average of the data obtained from the tensile coupons adjacent to the components that were included in the welded specimens which constitute the particular series shown on each master data sheet.

Standard tensile coupons for obtaining properties of the deposited weld material were fabricated, machined and tested according to American Welding Society specifications (4) . Five coupons from each electrode type used in fabricating the test specimens were tested and the average of the test results are reported in Table 2.

The properties reported for the rutile and acid coated electrodes are representative of their performance, but the basic type electrode should have exhibited a greater ductility than that shown in Table 2.

Welding of the tensile coupons was done six weeks after welding of the test specimens, and during this time, the electrodes were stored in a heated cabinet along with many other type electrodes. Temperature in the storage cabinet was high enough for other electrodes but as the basic type was a low hydrogen electrode and its coating has an acute affinity for moisture the temperature should have been higher for this electrode. From this moist coating resulted a high porosity weld metal in the tensile coupons. This had little or no effect on the ultimate strength but hampered the ductility. The per cent elongation is reported as 13% but it should have been at least 22% according to manufacturer's specifications.

Fabrication

The specimens tested at Georgia Institute of Technology were designated as Lot No. Six in the International Institute of Welding Document XV-121-61 (1). The specimens were fabricated in a local boiler shop by a certified welder. The control number of each component of the connection was supplied to the welder for purpose of assembly. Also, the type of electrode was specified. The commercial name, required diameter of electrodes, amperage to be used and fabrication procedure were left to the choice and discretion of the welder. All such pertinent data was recorded and reported on the master data sheets in Appendix C.

Measurements

All dimensions of the components of the specimens were carefully measured with a machinist micrometer to the nearest hundreth of a cm. Length of the fillet welds were measured to the nearest tenth of a cm with a graduated scale. Leg length and throat depth were measured with a micrometer dial gage to the nearest hundreth of a cm.

The throat area was determined by plotting to a large scale on graph paper the measured leg lengths and connecting these two points with a straight line to form a triangle. A line was then erected perpendicular to the hypothenuse and extended through the vertex of the triangle. The measured length of this line multiplied by the measured length of the weld was recorded as the area of the weld. The throat depth measured at forty-five degrees by the micrometer dial gage was also plotted as a check to insure that the inscribed triangle was always inside the fillet weld.

In practically all fillets the horizontal leg was slightly longer than the vertical leg. This meant the inscribed throat depth was at some angle slightly greater than forty-five degrees measured from the horizontal. This is compatible with the location of the rupture planes shown on the master data sheets. The rupture plane in the welds was in practically all cases between forty-five and sixty degrees measured from the horizontal.

Testing

The specimens were allowed to cure in a dry room at normal temperature for a period of at least fifteen days after fabrication. They were then loaded in tension by a 204,000 Kg capacity Riehle Mechanical Testing Machine. (See Fig. 6.) A strain rate of 0.025 inches (0.0635 cm) per minute was used.

Elongations of each specimen during loading were determined by a particular arrangement of six micrometer dial gages (See Fig. 7). Elongations were recorded to the nearest hundreth of a mm at load increments of 5000 KS points for measurements as were outlined in the II W Doc. XV-121-61 (1) (Also, see Fig. 8 and Fig. 9).

SUMMARY

All tests were considered satisfactory. The specimens exhibited uniformity throughout the testing program. No brittle failures in the steel plates were encountered. Specimens with only the transverse welds failed suddenly with a rapid decrease in load and there was always a loud report at the instant of failure. Specimens with only the longitudinal welds reached an ultimate load after which the load gradually decreased as a progressive shear plane developed in the weldment. This shear plane always originated at the corners of the strip and progressed inward toward the end of the pull pieces. This was caused by bending in the strip which tended to raise the end of the strips and induced a triaxial strain in the weldment. The bending in the strips was produced by the internal moment that was built up during loading from the eccentric loads on the strips.

Specimens with both transverse and longitudinal welds failed in different manners depending upon the ratio of the weld areas. The transverse weld failed first and depending upon the relative size of the longitudinal weld, the failure was either sudden or gradual. But in no case was there ever any increase in load above the ultimate load which caused initial failure of the transverse weld even though considerably more strain had to be applied before failure of the longitudinal welds occurred.

BIBLIOGRAPHY

1. Proposal for International Test Series II, International Institute of Welding Doc. XV-121-61, February, 1961.

2. ASTM Standards, Part I, Ferrous Metals Specifications, American Society for Testing Materials, Page 551, 1961.

3. ASTM Standards, Part 3, Metals Test Methods (Except Chemical Analysis), American Society for Testing Materials, Page 165, 1961.

4. Welding Handbook, Section One, American Welding Society, Page 9.6, 1957.

APPENDIX A

TABLE 1. PARENT MATERIAL TENSILE COUPON DATA

Plate Thickness cm	Specimen #	Kg/cm^2	%	Kg/cm^2	%	Reduction in Area %
1.56	1	2480	1.15	4570	26.9	54.9
	2	2550	1.20	4600	25.8	41.2
	3	2450	1.20	4640	27.5	54.6
	4	2520	1.00	4580	27.4	54.2
	5	2515	1.20	4570	29.0	51.2
	6	2500	1.30	4550	26.9	43.0
	7	2510	1.25	4650	30.1	55.0
2.58	8	2390	1.15	4520	30.2	54.1
	9	2350	1.20	4700	27.8	47.6
	10	2510	1.00	4840	27.8	31.4
	11	2290	1.10	4610	32.8	49.5
	12	2410	1.10	4490	31.3	55.3
	13	2280	1.25	4610	31.3	50.5
	14	2250	0.99	4590	30.0	51.0
	15	2240	1.25	4610	29.0	50.0
	16	2550	1.10	4540	28.5	54.6
	17	2330	1.00	4470	31.1	50.8
	18	2310	1.10	4475	29.5	54.0
	19	2290	1.20	4500	29.3	53.8
	20	2270	1.20	4530	28.5	54.6
	21	2380	1.25	4520	27.9	54.2
	22	2280	1.00	4570	27.9	54.8
	23	2370	1.20	4800	35.0	45.0
	24	2320	1.10	4640	30.4	51.2
	25	2370	1.12	4540	29.5	51.8
	26	2290	1.16	4500	29.1	54.1
	27	2330	1.14	4520	29.3	53.0
3.27	28	2330	0.90	4580	32.2	64.0
	29	2345	1.15	4580	32.5	64.0
	30	2280	1.00	4610	32.5	64.5
	31	2300	0.90	4580	28.4	63.8

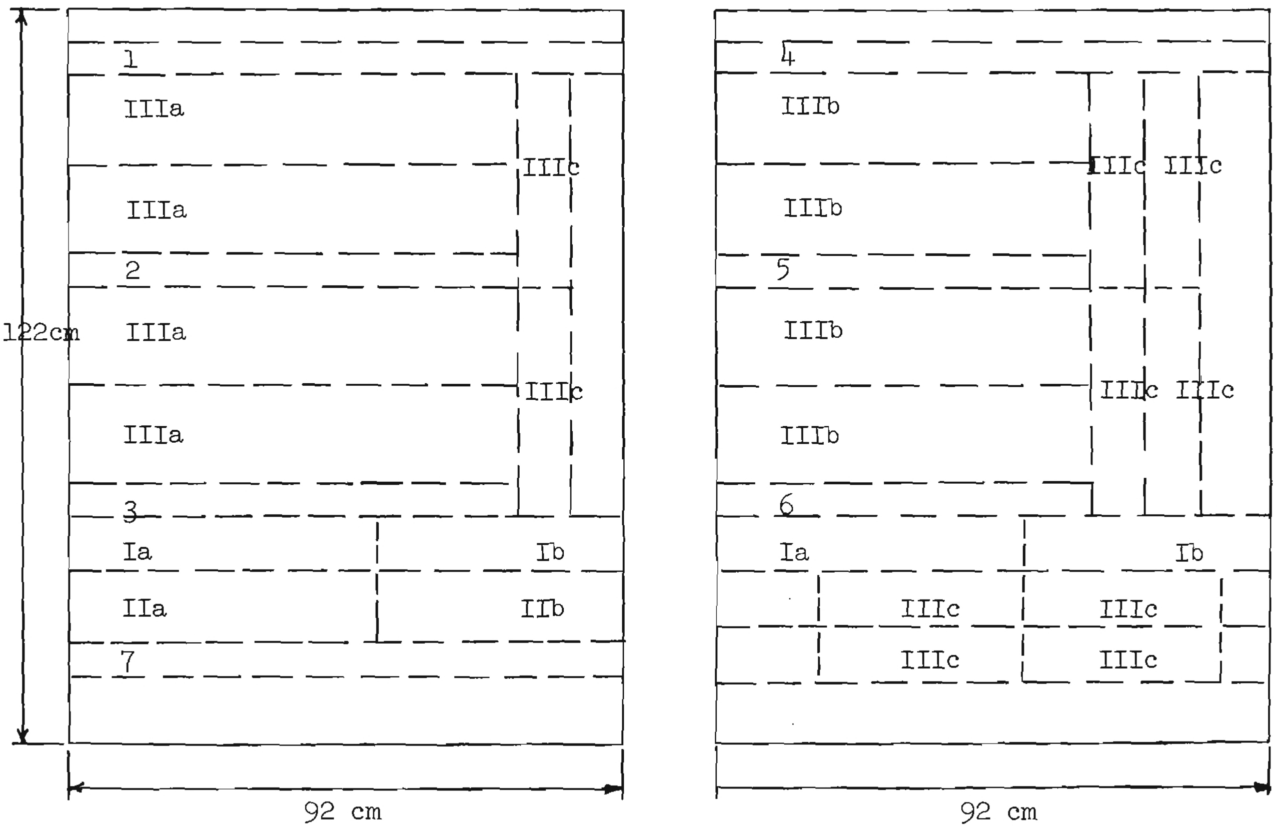
Plate Thickness cm	Specimen	Kg/cm^2	%	Kg/cm^2	%	Reduction in Area %
	32	2330	1.00	4540	33.2	64.0
	33	2370	1.05	4590	31.5	63.7
	34	2365	1.25	4420	33.6	63.7
	35	2360	1.05	4540	26.3	62.7
	36	2330	1.00	4480	33.8	63.8
	37	2300	0.95	4610	32.3	62.5
	38	2310	0.90	4590	31.2	63.5
	39	2290	1.20	4580	33.1	62.5
	40	2290	1.00	4570	33.0	63.4
	41	-	-	4500	33.5	64.5
	42	2320	1.10	4570	31.9	63.3
	43	2280	1.10	4450	34.1	64.6
	44	2270	1.00	4560	31.9	62.3
	45	2370	1.20	4480	25.0	64.7
1.89	46	2180	1.00	4220	28.2	56.6
	47	2250	0.90	4430	26.9	54.0
	48	2260	1.10	4410	26.2	55.9
	49	2250	1.50	4350	30.3	56.6
	50	2270	1.15	4370	30.5	58.5
	51	2215	1.20	4350	30.3	56.6
	52	2360	1.20	4450	29.3	57.3
	53	2205	0.90	4510	30.4	56.5
	54	2245	1.00	4420	25.0	54.2
	55	2180	1.00	4420	27.8	58.2
	56	2210	1.06	4320	30.0	58.0
	57	2220	1.10	4360	30.6	58.9
	58	2210	1.05	4560	30.2	54.5
	59	2245	1.10	4430	30.2	59.3
	60	2240	1.10	4430	27.5	54.6
	61	2250	1.15	4460	28.1	54.9
	62	2360	1.00	4490	26.8	53.1
	63	2330	1.05	4470	29.3	54.6

TABLE 2. DEPOSITED WELDMATERIAL TENSILE COUPON DATA*

Electrode				Reduction in Area
	Kg/cm^2	Kg/cm^2	%	%
E 7014 (Rutile)	4180	4810	22.3	41.3
E 7018 (Basic)	4595	5555	13.0	22.5
E 6027 (Acid)	3780	4630	31.5	60.7

* Average of data from 5 coupons for each electrode

APPENDIX B



Ia - 9cm x 51cm
Ib - 9cm x 41cm
Ic - 4.5cm x 31cm
IIa - 11cm x 51cm
IIb - 11cm x 41cm
IIc - 5.5cm x 31cm
IIIa - 16cm x 51cm
IIIb - 16cm x 41cm
IIIc - 8cm x 31cm
1 through 63 - Tensile coupons for Parent Material

Figure 1. Layout of Components of the Test Specimens from 1.56 cm Steel Plate.

2.58cm Steel Plate

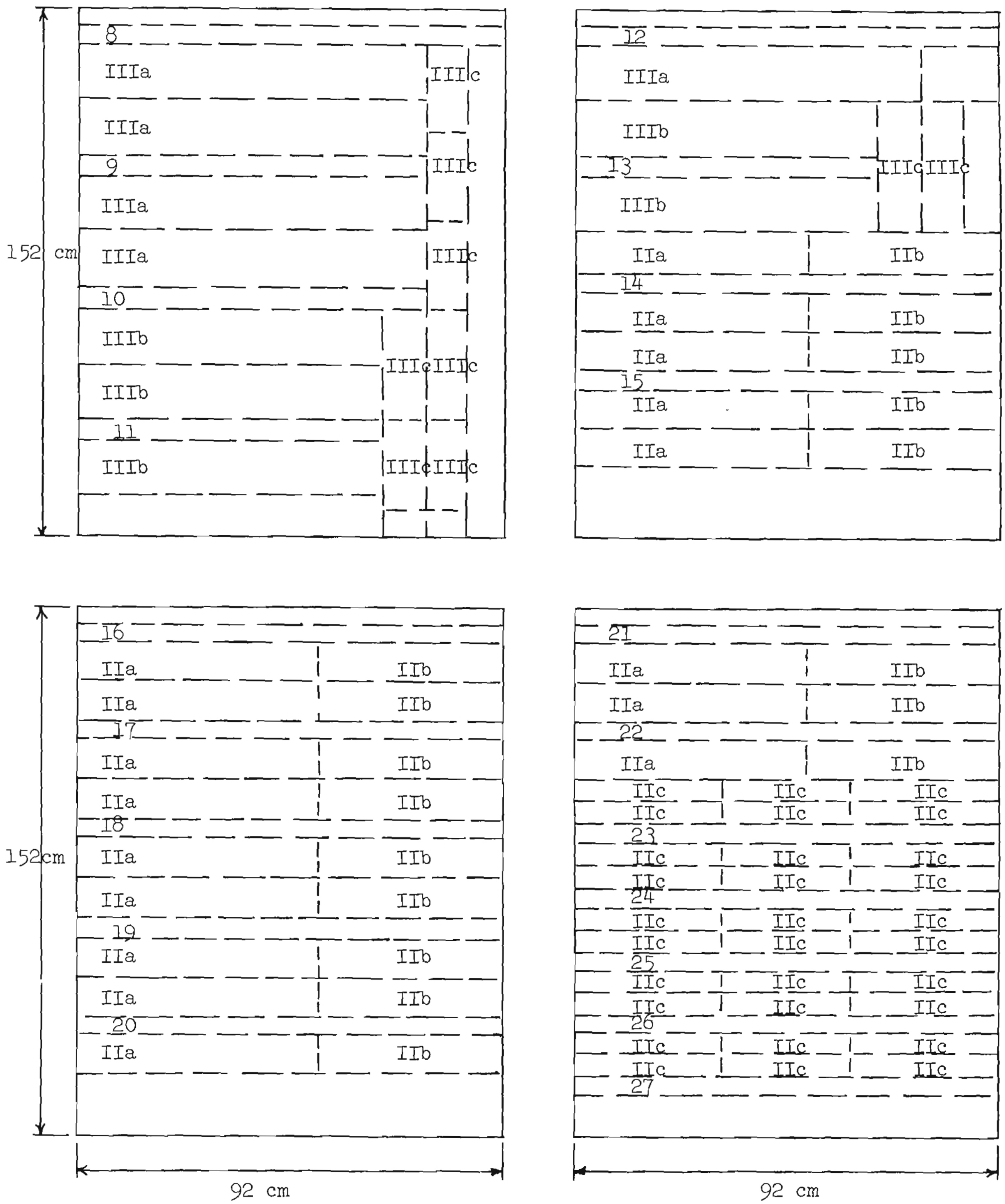


Figure 2. Layout of Components of the Test Specimens from 2.58 cm Steel Plate.

3.27 cm Steel Plate

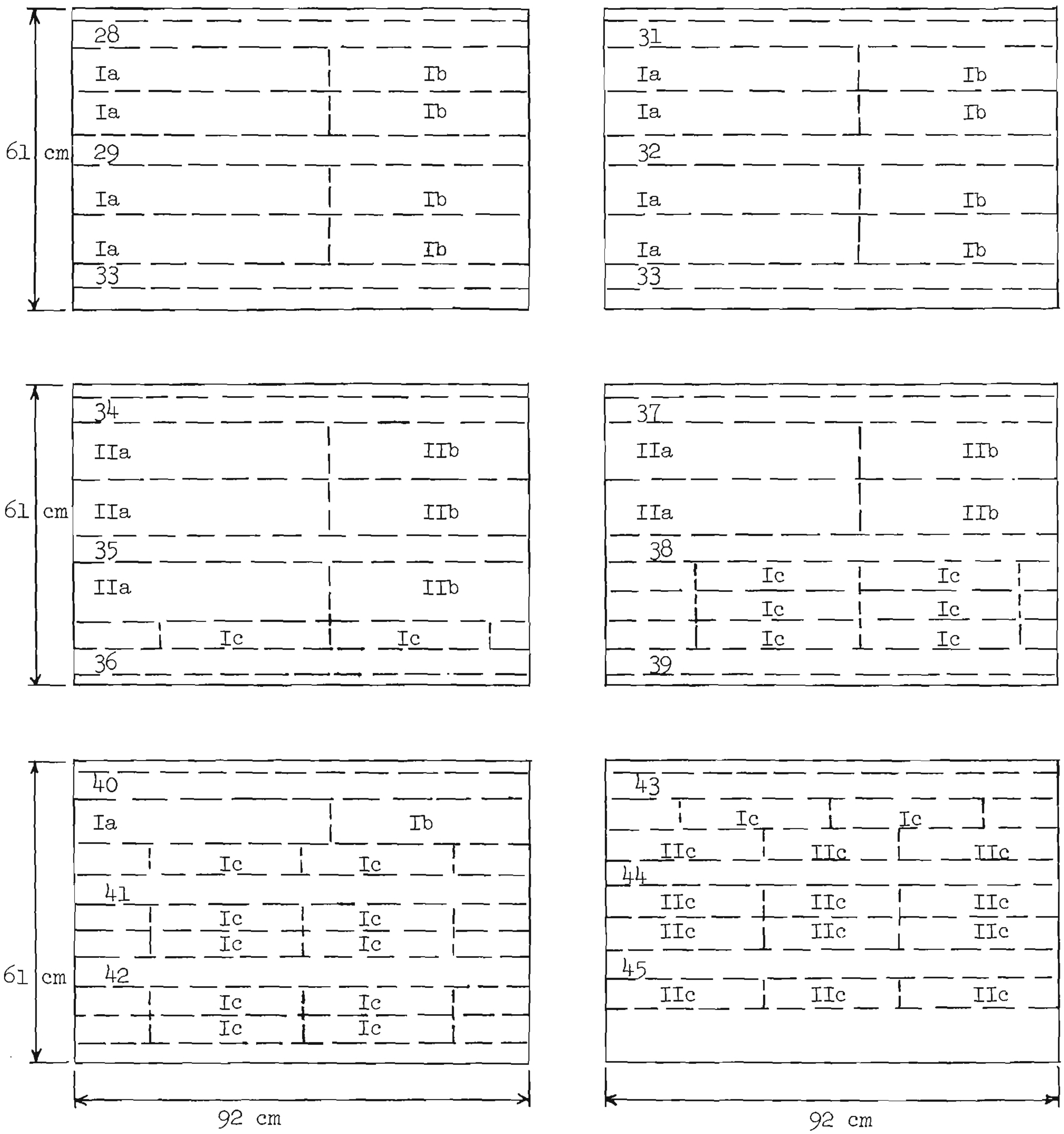


Figure 3. Layout of Components of the Test Specimens from 3.27 cm Steel Plate.

1.89 cm Steel Plate

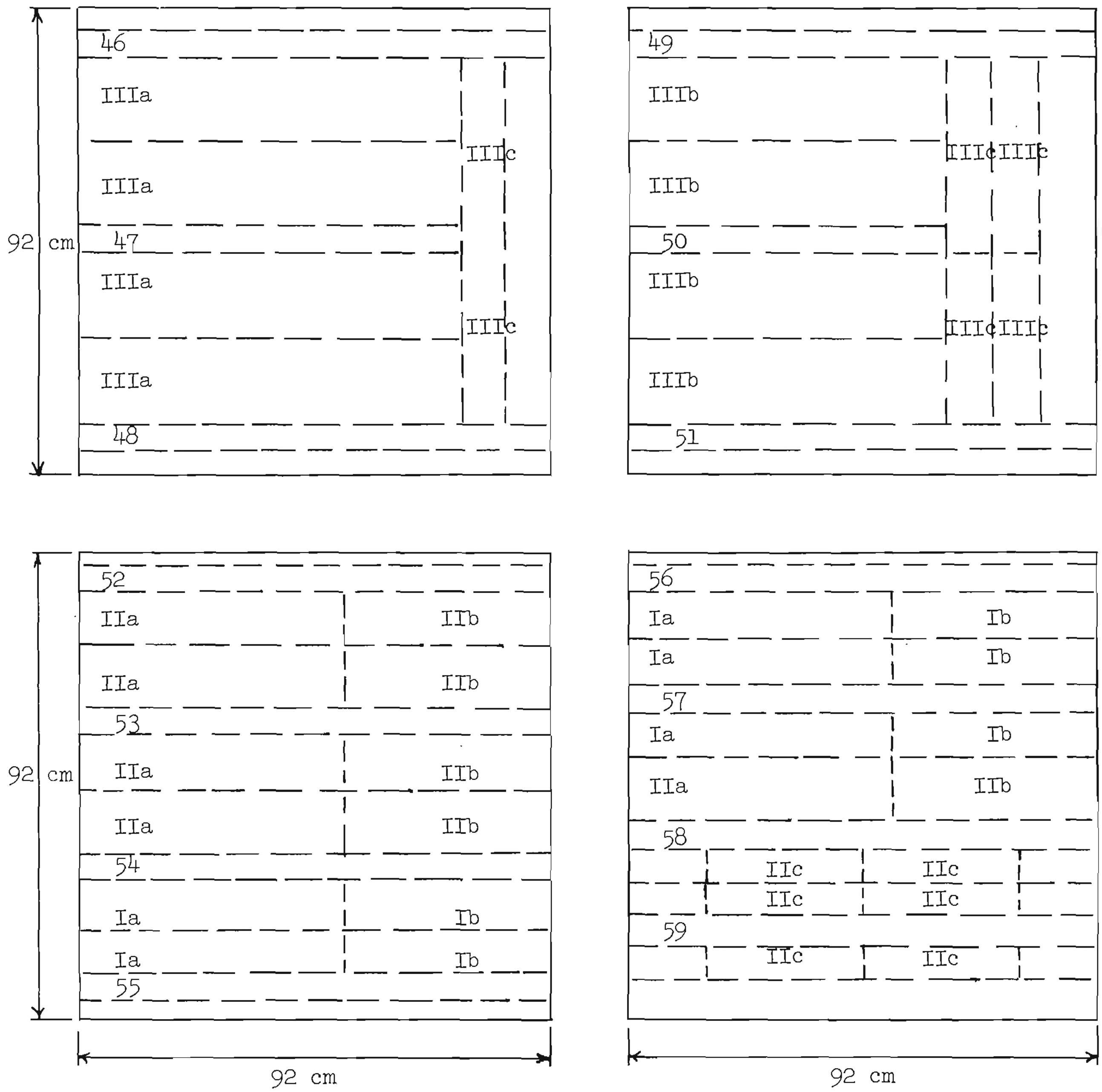


Figure 4. Layout of Components of the Test Specimens from 1.89 cm Steel Plate.

1.89 cm Steel Plate

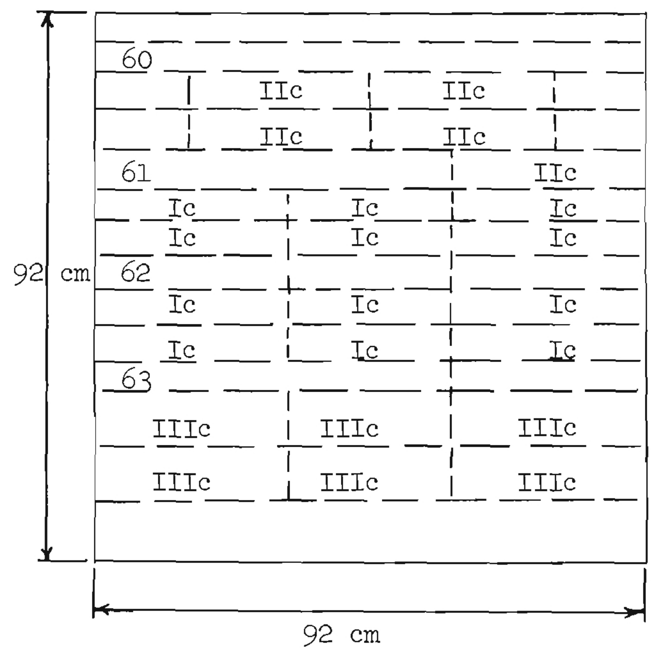


Figure 5. Layout of Component of the Test Specimens from 1.89 cm Steel Plate.

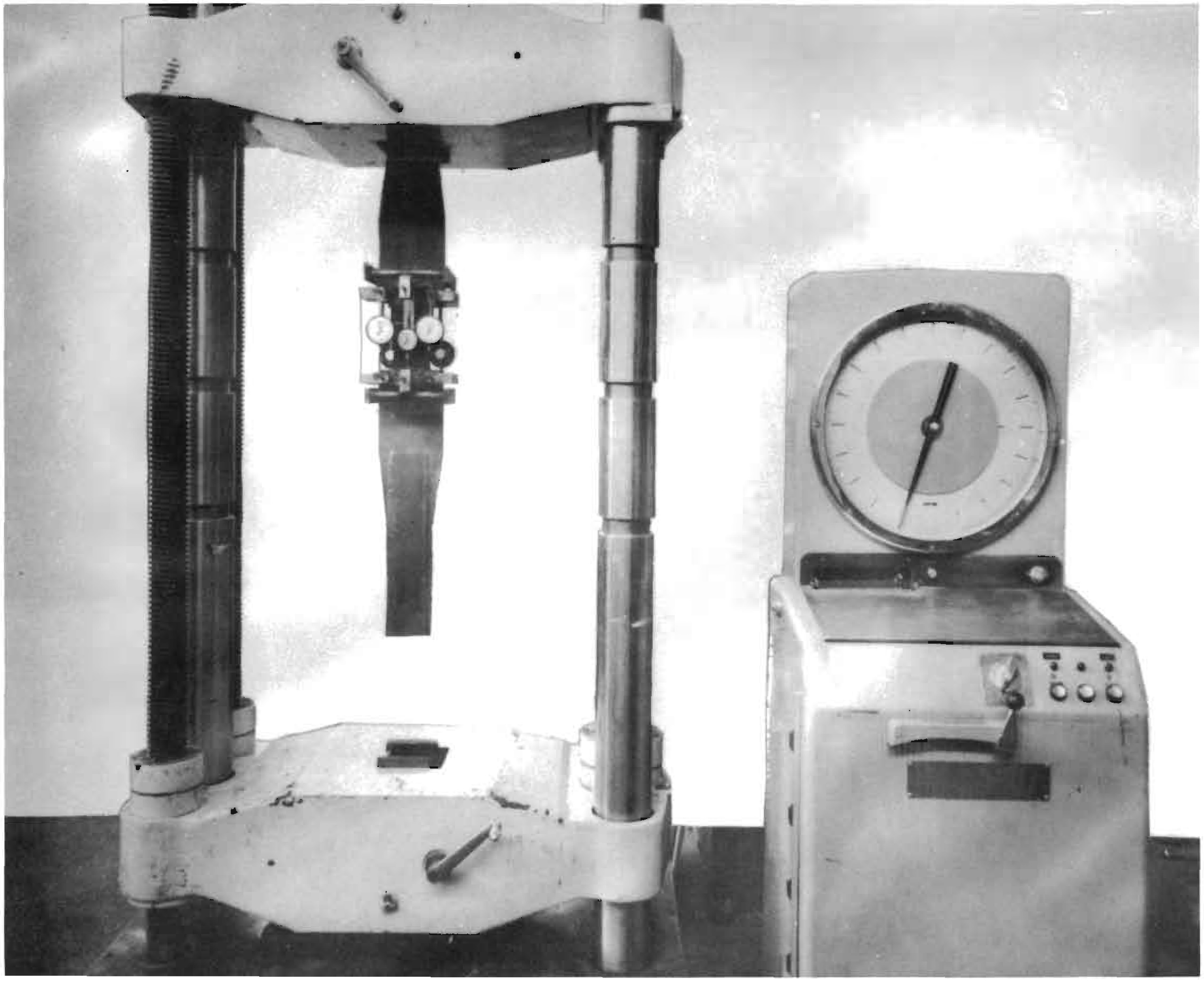


Figure 6. Typical Test Arrangement.

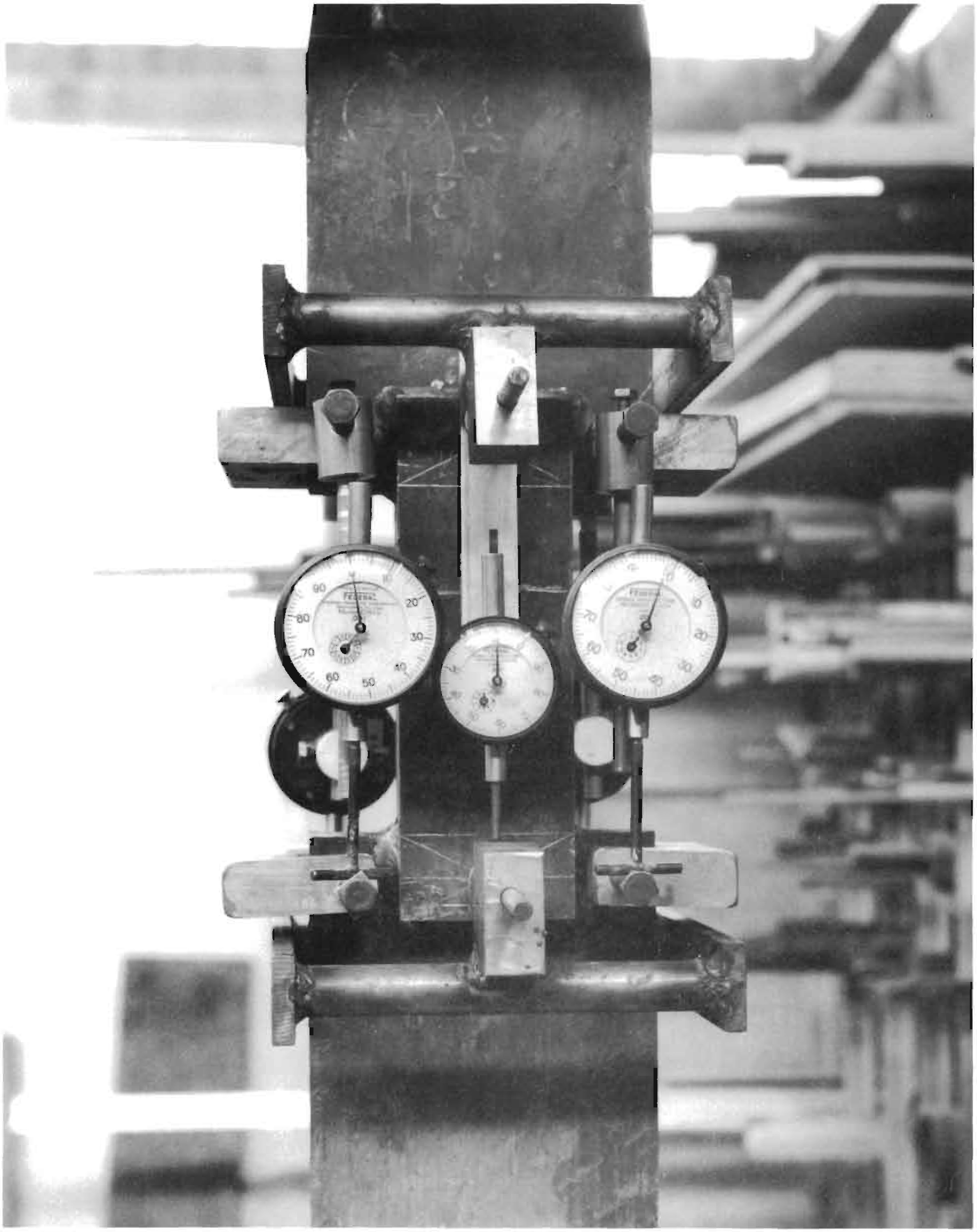


Figure 7. Test Specimen and Instrumentation.

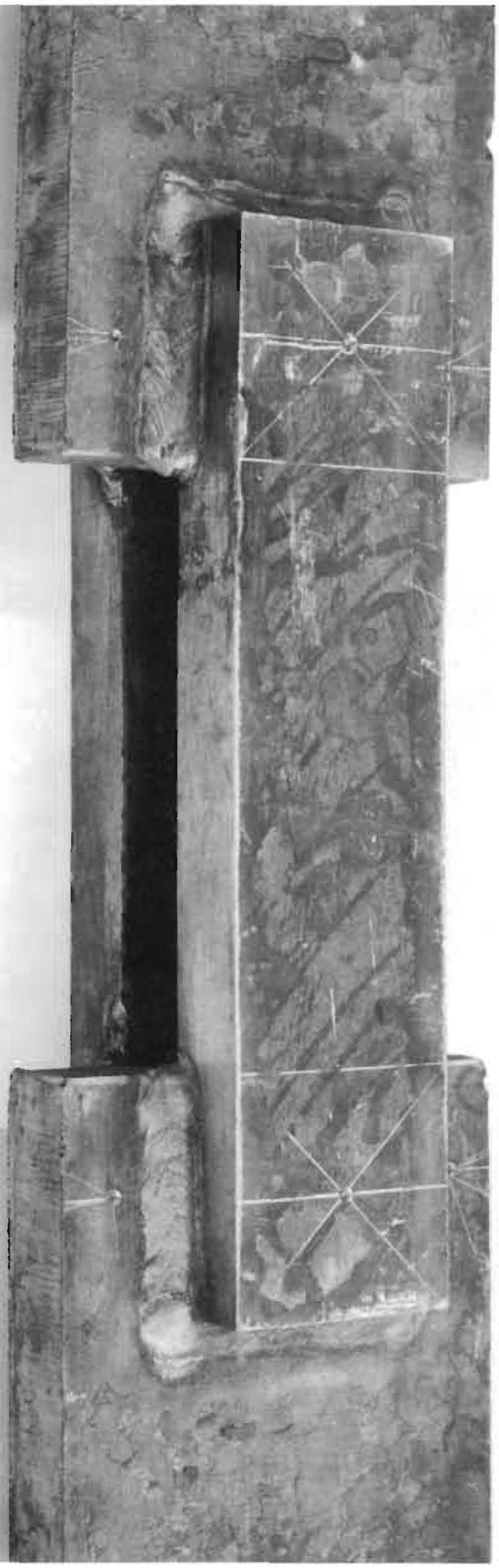


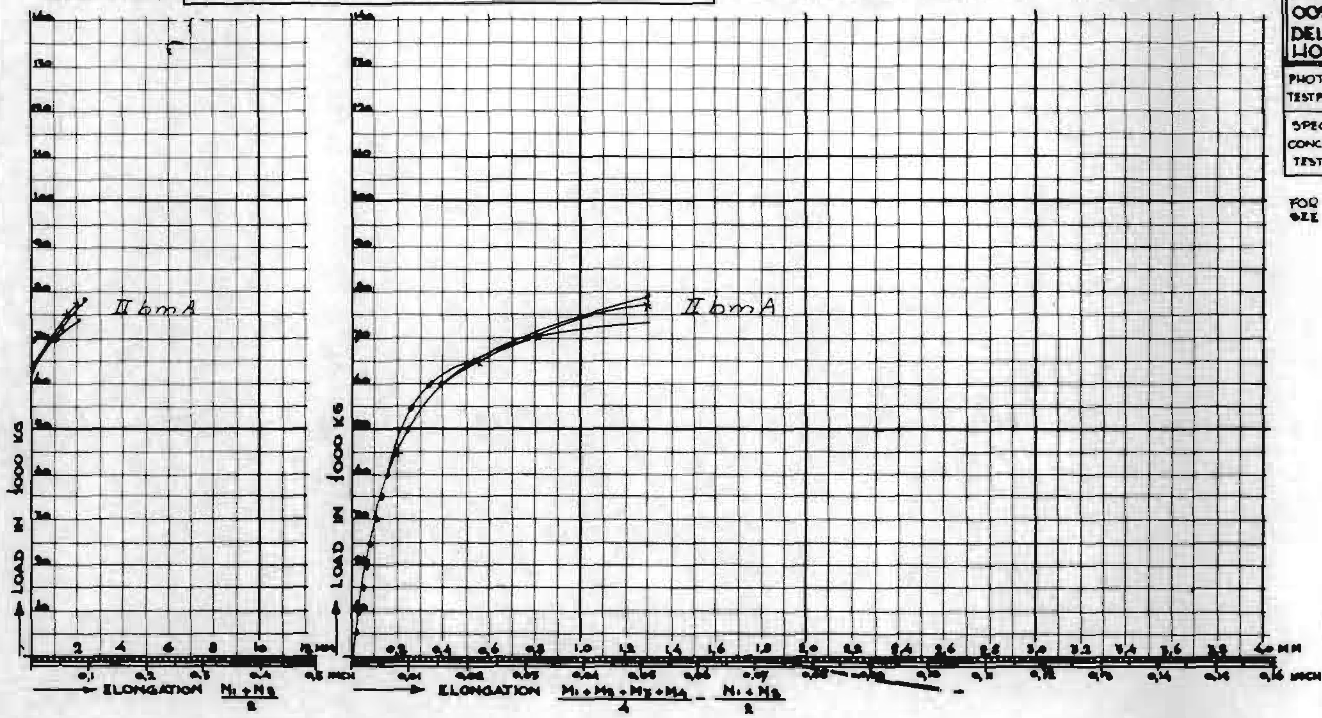
Figure 8. Test Specimen Before Loading.

Figure 9. Test Specimen After Loading.

APPENDIX C

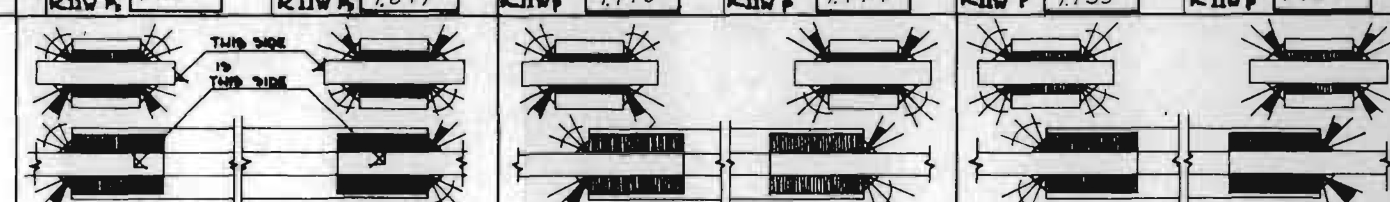
COUNTRY: UNITED STATES — ORIGINAL FORM HAS TO BE SENT TO → PROF. A.A. VAN DOUWEN, OOSTPLANTSOEN 25, DELFT, HOLLAND.

LOT NUMBER 6 — THREE IDENTICAL TESTPIECES FOR REFERENCE PURPOSES



	MAIN TEST PIECE [II bm A •]		MAIN TEST PIECE [II bm A :]		MAIN TEST PIECE [II bm A ⁝]	
PHOTOGRAPHS OF THE TESTPIECES ARE MARKED						
SPECIAL REMARKS CONCERNING THE TESTPIECES						
FOR THIS TESTPIECES SEE FIG № 10	NOMINAL	MEASURED	NOMINAL	MEASURED	NOMINAL	MEASURED
	t = 2,4 cm	t = 2.57 cm				
	h = 5.5 cm	h = 5.51 cm	h = 5,5 cm	h = 5.50 cm	h = 5,5 cm	h = 5.51 cm
	A_1 = 5,5 cm^2	A'_1 = 6.05 cm^2	A_1 = 5,5 cm^2	A'_1 = 5.80 cm^2	A_1 = 5.5 cm^2	A'_1 = 6.39 cm^2
	A_2 = 11 cm^2	A'_2 = 10.86 cm^2	A_2 = 11 cm^2	A'_2 = 11.07 cm^2	A_2 = 11 cm^2	A'_2 = 11.57 cm^2
	P_{RUPT} = 74,800 kg		P_{RUPT} = 78,880 kg		P_{RUPT} = 77,180 kg	

σ_c = 5000 kg/cm²	MAX	P_{MAX} = 82 500 kg	P'_{MAX} = 84,500 kg	P_{MAX} 82 500 kg	P'_{MAX} 84,400 kg	P_{MAX} 82 500 kg	P'_{MAX} 89,800 kg
	MAX	R_{MAX} = 0.907	R'_{MAX} = 0.885	R_{MAX} 0.956	R'_{MAX} 0.935	R_{MAX} 0.936	R'_{MAX} 0.860
	IIW	P_{IIW} = 48.900 kg	P'_{IIW} = 49,200 kg	P_{IIW} 48 900 kg	P'_{IIW} 49,600 kg	P_{IIW} 48 900 kg	P'_{IIW} 52,200 kg
	IIW	R_{IIW} = 1,528	R'_{IIW} = 1.520	R_{IIW} 1.611	R'_{IIW} 1.588	R_{IIW} 1,577	R'_{IIW} 1.480
σ_w = 4630 kg/cm² WELDMATERIAL	MAX	$P_{MAX\,W}$ = 76,400 kg	$P'_{MAX\,W}$ = 78,200 kg	$P_{MAX\,W}$ 76,400 kg	$P'_{MAX\,W}$ 78,100 kg	$P_{MAX\,W}$ 76,400 kg	$P'_{MAX\,W}$ 83,100 kg
	MAX	$R_{MAX\,W}$ = 0.980	$R'_{MAX\,W}$ = 0.956	$R_{MAX\,W}$ 1,034	$R'_{MAX\,W}$ 1.010	$R_{MAX\,W}$ 1,012	$R'_{MAX\,W}$ 0.929
	IIW	$P_{IIW\,W}$ = 45,250 kg	$P'_{IIW\,W}$ = 45,500 kg	$P_{IIW\,W}$ 45,250 kg	$P'_{IIW\,W}$ 45,950 kg	$P_{IIW\,W}$ 45,250 kg	$P'_{IIW\,W}$ 48,300 kg
	IIW	$R_{IIW\,W}$ = 1,650	$R'_{IIW\,W}$ = 1.642	$R_{IIW\,W}$ 1.741	$R'_{IIW\,W}$ 1.715	$R_{IIW\,W}$ 1,704	$R'_{IIW\,W}$ 1,600
σ_p = 4550 kg/cm² PARENT MATERIAL	MAX	$P_{MAX\,P}$ = 75,050 kg	$P'_{MAX\,P}$ = 76,900 kg	$P_{MAX\,P}$ 75,050 kg	$P'_{MAX\,P}$ 76,800 kg	$P_{MAX\,P}$ 75,050 kg	$P'_{MAX\,P}$ 81,700 kg
	MAX	$R_{MAX\,P}$ = 0.996	$R'_{MAX\,P}$ = 0.973	$R_{MAX\,P}$ 1,051	$R'_{MAX\,P}$ 1,027	$R_{MAX\,P}$ 1,029	$R'_{MAX\,P}$ 0.945
	IIW	$P_{IIW\,P}$ = 44,500 kg	$P'_{IIW\,P}$ = 44,800 kg	$P_{IIW\,P}$ 44.500 kg	$P'_{IIW\,P}$ 45,200 kg	$P_{IIW\,P}$ 44,500 kg	$P'_{IIW\,P}$ 47,500 kg
	IIW	$R_{IIW\,P}$ = 1.680	$R'_{IIW\,P}$ = 1.671	$R_{IIW\,P}$ 1.770	$R'_{IIW\,P}$ 1.774	$R_{IIW\,P}$ 1.733	$R'_{IIW\,P}$ 1.627



WELDING EQUIPMENT

MAKE	Lincoln Welder
TYPE	Motor Generator SAE 600

A.C. { TRANSFORMER. / ALTERNATOR.
D.C { GENERATOR. / RECTIFIER WELDING SET

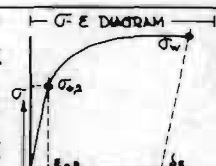
DIAMETER AND AMP.

	1st RUN DIAM.	1st RUN AMP.	2nd AND 3rd RUN DIAM.	2nd AND 3rd RUN AMP.
a_1	0.4	210		
a_2	0.4	210		
a_3				

ELECTRODE

		CHEMICAL ANALYSIS	
MAKE	Hobart	C	0.09 %
TYPE	Stick Electrode	S	0.017 %
STANDARD IIW SPECIFICATION	AWS E6027	P	0.008 %

σ-ε DIAGRAM



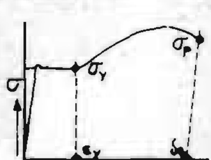
ELONGATION: δ_s 31.5 %

STRESS: σ_w = 4630 kg/cm² WELDMATERIAL; $\sigma_{0,2}$ 3180

IMPACT VALUE CHARPY V

	3 TESTS			MEAN	
0°C					ft-lb
20°C					ft-lb

C	0.26 %
S	0.026 %
P	0.009 %



δ_s 29.7 %; ε_y 1.13 %; σ_y 2330

σ_p = 4550 kg/cm² PARENT MATERIAL

TESTING MACHINE

MAKE	Riehle
TYPE AND POWER	7.5 HP 204,000 Kg
RANGE	0 → 10,200 kg 0 → 20,400 kg 0 → 40,800 kg 0 → 102,000 kg 0 → 204,000 kg
DRIVING SYSTEM	Screw
LOAD INDICATION	Reading of Pointer
PHOTOGRAPHS ARE MARKED	

NAME OF LABORATORY	Georgia Institute of Technology
NAME OF TOOLROOM	J.J. Finnigan Co.
NAME OF WELDER	L.C. Reese

SPECIAL REMARKS CONCERNING THE WAY OF BREAKING

COUNTRY: UNITED STATES

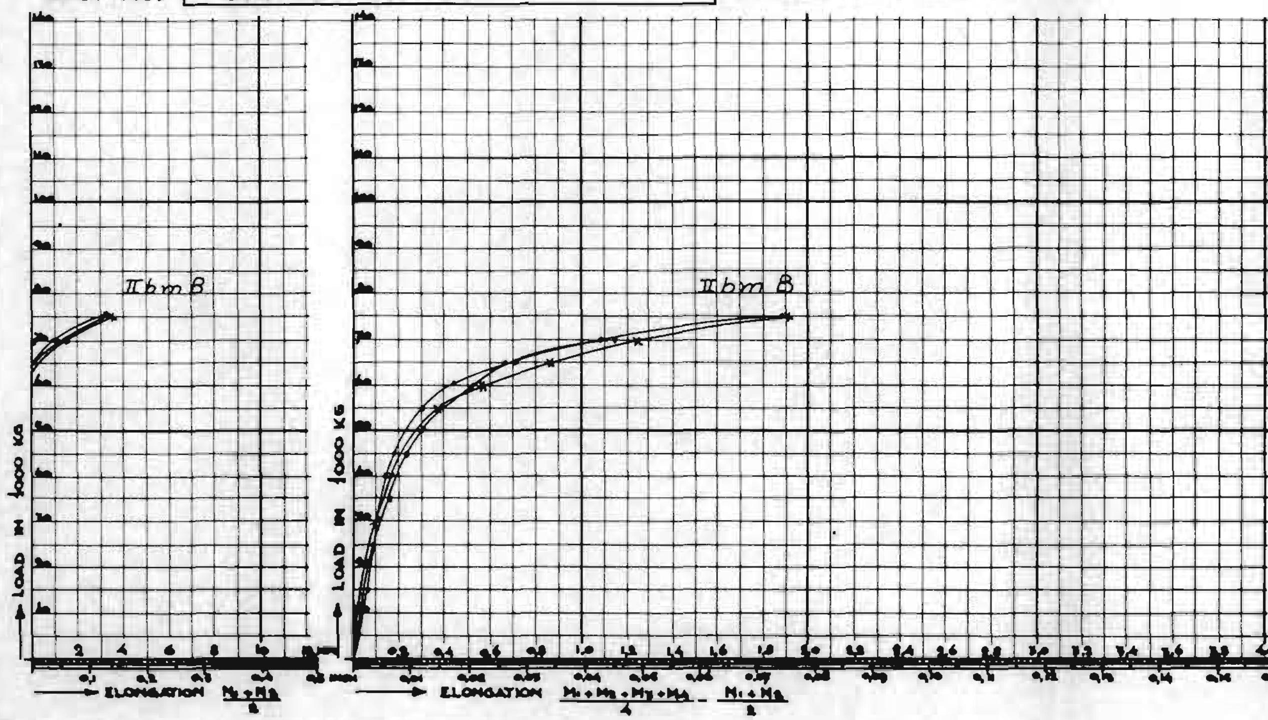
ORIGINAL FORM HAS TO BE SENT TO → PROF. A.A. VAN DOUWEN, OOSTPLANTSOEN 25, DELFT, HOLLAND.

PHOTOGRAPHS OF THE TESTPIECES ARE MARKED

SPECIAL REMARKS CONCERNING THE TESTPIECES

FOR THIS TESTPIECES SEE FIG NO 10

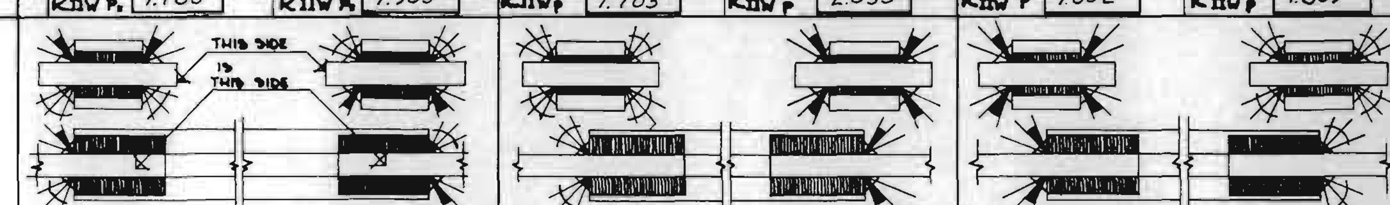
LOT NUMBER: 6 — THREE IDENTICAL TESTPIECES FOR REFERENCE PURPOSES



	MAIN TEST PIECE [II bm B.] NOMINAL	MAIN TEST PIECE [II bm B.] MEASURED	MAIN TEST PIECE [II bm B] NOMINAL	MAIN TEST PIECE [II bm B] MEASURED	MAIN TEST PIECE [II bm B] NOMINAL	MAIN TEST PIECE [II bm B] MEASURED
t (cm)	2.4	2.58				
h (cm)	5.5	5.50	5.5	5.50	5.5	5.51
A1 (cm²)	5.5	5.10	5.5	4.62	5.5	5.17
A2 (cm²)	11	9.72	11	9.16	11	9.66
P RUPT (KG)	75,590		75,820		74000	

		Nominal		Measured		Nominal		Measured		Nominal		Measured	
MAX	P_{MAX}	82.500 KG	P'_{MAX}	74,100 KG	P_{MAX}	82.500 KG	P'_{MAX}	68,900 KG	P_{MAX}	82.500 KG	P'_{MAX}	74,100 KG
	R_{MAX}	0.916	R'_{MAX}	1.020	R_{MAX}	0.919	R'_{MAX}	1.100	R_{MAX}	0.898	R'_{MAX}	1,000
IIW	P_{IIW}	48.900 KG	P'_{IIW}	43,600 KG	P_{IIW}	48.900 KG	P'_{IIW}	40,900 KG	P_{IIW}	48.900 KG	P'_{IIW}	43,500 KG
	R_{IIW}	1.547	R'_{IIW}	1.733	R_{IIW}	1.550	R'_{IIW}	1.852	R_{IIW}	1.513	R'_{IIW}	1.700
MAX	$P_{MAX\,W}$	91,700 KG	$P'_{MAX\,W}$	82,400 KG	$P_{MAX\,W}$	91,700 KG	$P'_{MAX\,W}$	76,550 KG	$P_{MAX\,W}$	91,700 KG	$P'_{MAX\,W}$	82,400 KG
	$R_{MAX\,W}$	0.825	$R'_{MAX\,W}$	0.918	$R_{MAX\,W}$	0,826	$R'_{MAX\,W}$	0.989	$R_{MAX\,W}$	0,809	$R'_{MAX\,W}$	0.900
IIW	$P_{IIW\,W}$	54,400 KG	$P'_{IIW\,W}$	48,450 KG	$P_{IIW\,W}$	54,400 KG	$P'_{IIW\,W}$	45,500 KG	$P_{IIW\,W}$	54,400 KG	$P'_{IIW\,W}$	48,400 KG
	$R_{IIW\,W}$	1.391	$R'_{IIW\,W}$	1.559	$R_{IIW\,W}$	1.394	$R'_{IIW\,W}$	1.666	$R_{IIW\,W}$	1,362	$R'_{IIW\,W}$	1.529
MAX	$P_{MAX\,P}$	75,050 KG	$P'_{MAX\,P}$	67.450 KG	$P_{MAX\,P}$	75,050 KG	$P'_{MAX\,P}$	62,700 KG	$P_{MAX\,P}$	75,500 KG	$P'_{MAX\,P}$	67,450 KG
	$R_{MAX\,P}$	1.006	$R'_{MAX\,P}$	1,121	$R_{MAX\,P}$	1.010	$R'_{MAX\,P}$	1.209	$R_{MAX\,P}$	0.988	$R'_{MAX\,P}$	1.099
IIW	$P_{IIW\,P}$	44,500 KG	$P'_{IIW\,P}$	39.700 KG	$P_{IIW\,P}$	44,500 KG	$P'_{IIW\,P}$	37,200 KG	$P_{IIW\,P}$	44500 KG	$P'_{IIW\,P}$	39.600 KG
	$R_{IIW\,P}$	1.700	$R'_{IIW\,P}$	1.905	$R_{IIW\,P}$	1.703	$R'_{IIW\,P}$	2.035	$R_{IIW\,P}$	1.662	$R'_{IIW\,P}$	1.869

σ_c. 5000 KG/cm²



WELDING EQUIPMENT

MAKE: Lincoln Welder

TYPE: Motor Generator SAE 600

A.C. { TRANSFORMER, ALTERNATOR

D.C { GENERATOR, RECTIFIER WELDING SET

DIAMETER AND AMP.

	1st RUN DIAM.	1st RUN AMP.	2nd AND 3 RUN DIAM.	2nd AND 3 RUN AMP.
a_1	0.4	175		
a_2	0.4	175		
a_3				

ELECTRODE

MAKE: Hobart

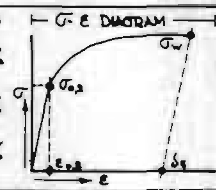
TYPE: Stick Electrode

STANDARD IIW SPECIFICATION: AWS E7018

CHEMICAL ANALYSIS

C	0.06 %
S	0.017 %
P	Nil %

σ-ε DIAGRAM



ELONGATION: δ_5 13.0 %

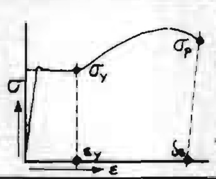
STRESS: σ_w. 5555 KG/cm² — WELDMATERIAL

$\sigma_{0.2}$ 4595

IMPACT VALUE CHARPY V

	3 TESTS			MEAN	
0°C					ft-lb
20°C					ft-lb

C	0.26 %
S	0.026 %
P	0.009 %



δ_5 29.7 %

σ_p. 4550 KG/cm² — PARENT MATERIAL

ε_y 1.13 % σ_y 2330

TESTING MACHINE

MAKE: Riehle

TYPE AND POWER: 7.5 HP 204,000 kg

RANGE: 0→10,200kg 0→20,400kg 0→40,800kg 0→102,000kg 0→204,000kg

DRIVING SYSTEM: Screw

LOAD INDICATION: Reading of Pointer

PHOTOGRAPHS ARE MARKED

NAME OF LABORATORY: Georgia Institute of Technology

NAME OF TOOLROOM: J.J Finnigan Co.

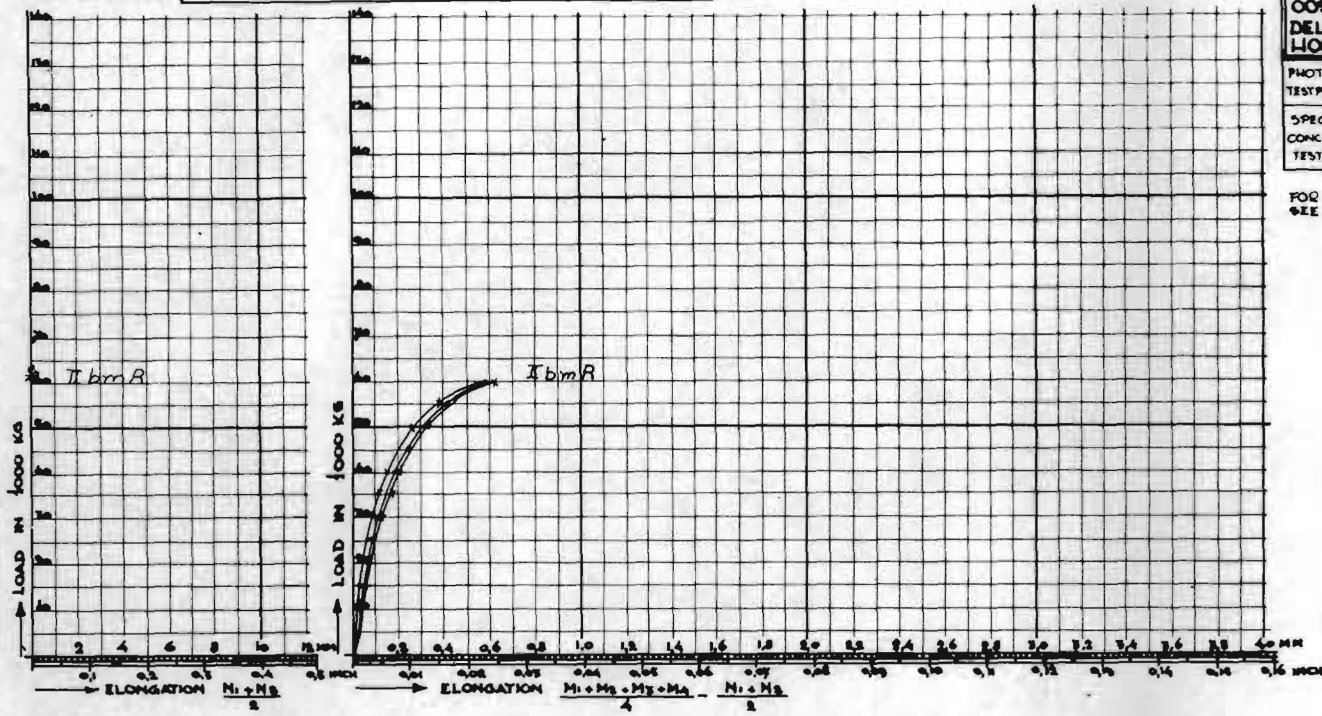
NAME OF WELDER: L. C. Reese

SPECIAL REMARKS CONCERNING THE WAY OF BREAKING

COUNTRY: UNITED STATES

ORIGINAL FORM HAS TO BE SENT TO → PROF. A.A. VAN DOUWEN, OOSTPLANTSOEN 25, DELFT, HOLLAND.

LOT NUMBER: 0 — THREE IDENTICAL TESTPIECES FOR REFERENCE PURPOSES



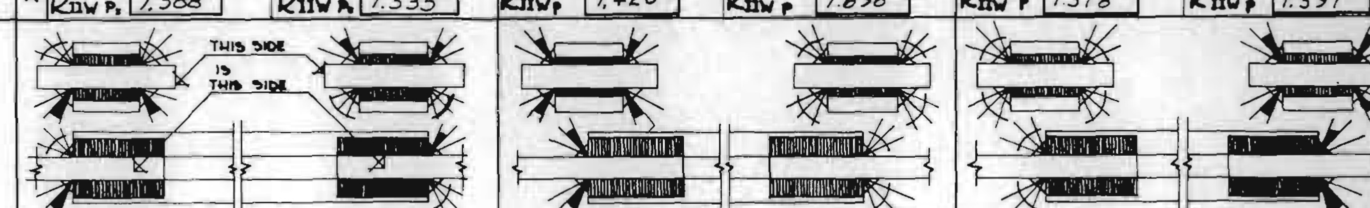
PHOTOGRAPHS OF THE TESTPIECES ARE MARKED

SPECIAL REMARKS CONCERNING THE TESTPIECES

FOR THIS TESTPIECES SEE FIG Nº 10

	MAIN TEST PIECE [II bm R •] NOMINAL	MEASURED	MAIN TEST PIECE [II bm R :] NOMINAL	MEASURED	MAIN TEST PIECE [II bm R ⁝] NOMINAL	MEASURED
t (cm)	2,4	2.58				
h (cm)	5.5	5.51	5,5	5.51	5,5	5.51
A1 / A'1 (cm²)	5,5	4.82	5,5	4.50	5.5	5.06
A2 / A'2 (cm²)	11	9.97	11	9.23	11	9.37
P RUPT (kg)	61,740		63,100		61,293	
P_{MAX} / P'_{MAX} (kg)	82.500	74,000	82 500	68,700	82.500	72,200
R_{MAX} / R'_{MAX}	0.749	0.835	0.765	0.919	0.744	0.849
P_{IIW} / P'_{IIW} (kg)	48.900	44,200	48 900	40,900	48.900	42,200
R_{IIW} / R'_{IIW}	1.263	1.397	1.291	1.542	1.254	1.453
$P_{MAX\,W}$ / $P'_{MAX\,W}$ (kg)	79,450	71,250	79.450	66,100	79.450	69,500
$R_{MAX\,W}$ / $R'_{MAX\,W}$	0.779	0.869	0.795	0.955	0.774	0.883
$P_{IIW\,W}$ / $P'_{IIW\,W}$ (kg)	47,100	42,550	47,100	39,400	47,100	40,700
$R_{IIW\,W}$ / $R'_{IIW\,W}$	1.313	1.452	1.344	1.605	1.304	1.512
$P_{MAX\,P}$ / $P'_{MAX\,P}$ (kg)	75,050	67,400	75,050	62,500	75,050	65,700
$R_{MAX\,P}$ / $R'_{MAX\,P}$	0.823	0.917	0.841	1,010	0.817	0,932
$P_{IIW\,P}$ / $P'_{IIW\,P}$ (kg)	44,500	40,250	44,500	37,200	44,500	38,400
$R_{IIW\,P}$ / $R'_{IIW\,P}$	1.388	1.535	1,420	1.696	1.378	1.597

σ_c: 5000 kg/cm²



WELDING EQUIPMENT

MAKE: Lincoln Welder

TYPE: motor Generator SAE 600

A.C. {TRANSFORMER. ALTERNATOR.

D.C. {GENERATOR. RECTIFIER WELDING SET

DIAMETER AND AMP.

	1st RUN DIAM.	1st RUN AMP.	2nd AND 3rd RUN DIAM.	2nd AND 3rd RUN AMP.
a_1	0.5	195		
a_2	0.5	195		
a_3				

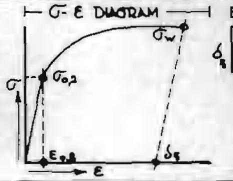
ELECTRODE

MAKE	Hobart
TYPE	Stick Electrode
STANDARD IIW SPECIFICATION	A.W.S. E7014

CHEMICAL ANALYSIS

	Weld	Parent
C	0.07 %	0.26 %
S	0.00 %	0.026 %
P	0.001 %	0.009 %

σ-ε DIAGRAM



ELONGATION: δ_5 22.3 %

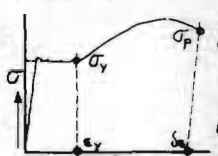
STRESS: σ_w = 4810 kg/cm²

WELDMATERIAL

$\sigma_{0.2}$ 4180

IMPACT VALUE CHARPY V

	3 TESTS			MEAN	
0°C					ft-lb
20°C					ft-lb



δ_5 29.7 %

ε_y 1.13 % σ_y 2330

σ_p 4550 kg/cm²

PARENT MATERIAL

TESTING MACHINE

MAKE	Riehle
TYPE AND POWER	7.5 HP 204.000 kg
RANGE	0→10,200 kg 0→20,400 kg 0→40,800 kg 0→102,000 kg 0→204,000 kg
DRIVING SYSTEM	Screw
LOAD INDICATION	Reading of Pointer
PHOTOGRAPHS ARE MARKED	

NAME OF LABORATORY	Georgia Institute of Technology
NAME OF TOOLROOM	J. J. Finnigan Co.
NAME OF WELDER	L. C. Reese

SPECIAL REMARKS CONCERNING THE WAY OF BREAKING